Experiment No.:06

Name of the Experiment: Half-Wave and Full-Wave Controller Rectifier Circuit with PI controller and P&O Method with Fixed and Variable Step Size

Objectives:

- To Use PI Controller to Generate Gate Pulse for Half-Wave and Full-Wave Controlled Rectifier Circuit
- To Learn and Implement of MATLAB Function Code Synchronization Per Cycle of Waveform
- To develop a Controller of Fixed Pulse Algorithm and Variable Pulse Algorithm and Implement on Half-Wave and Full-Wave Circuit

Software Package:

- MATLAB
- Simulink

Half-Wave Controlled Rectifier (PI Controller):

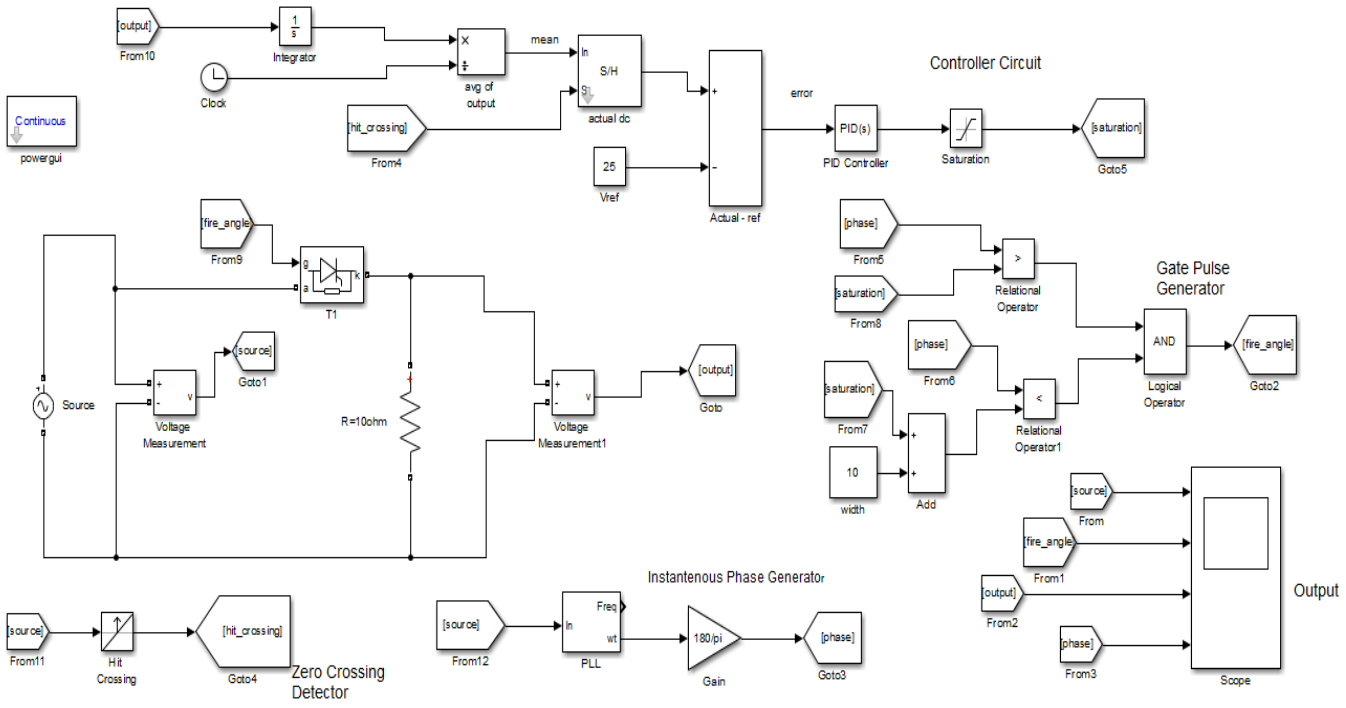

Figure 1.1.: Half Wave Controlled Rectifier Circuit with PI Controller to Achieve Reference Voltage = 25V in Simulink

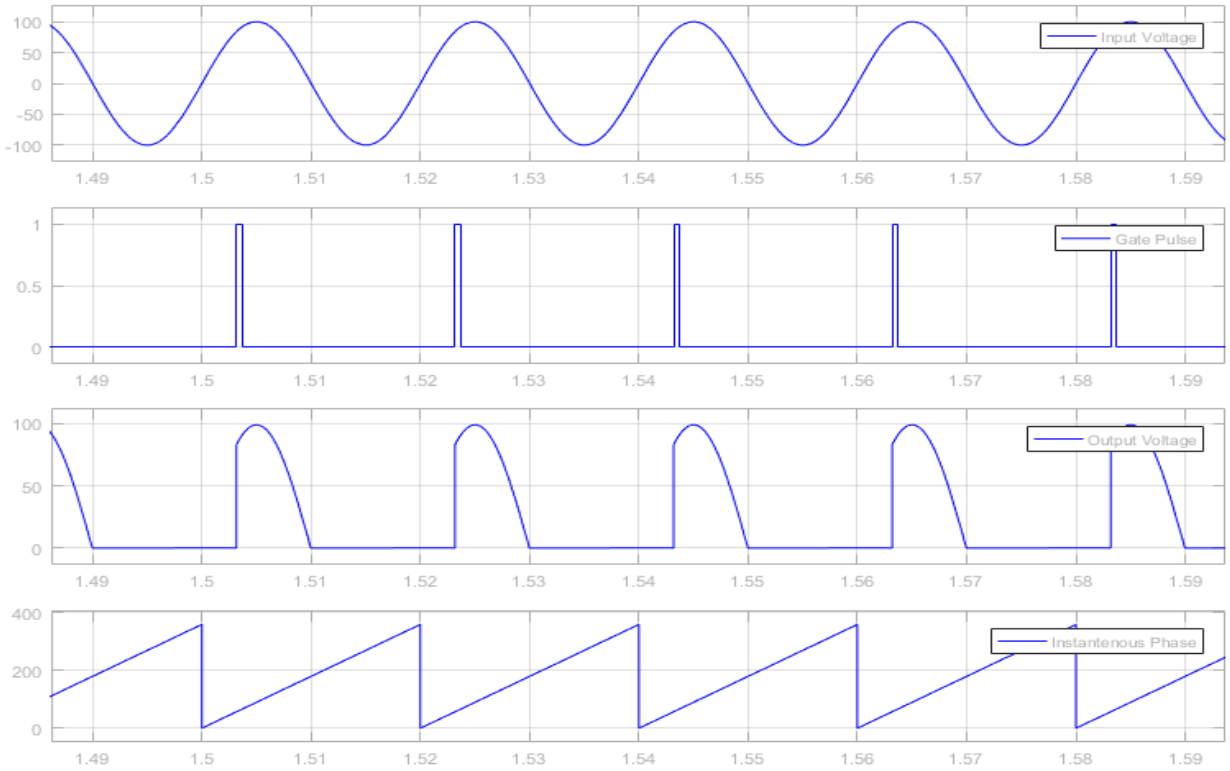

Figure 1.2.: Input, Gate Pulse, Output Voltage and Instantaneous Phase of Half -Wave Controlled Rectifier Circuit with PI Controller (Vref = 25V) in Simulink

Half-Wave Controlled Rectifier with Fixed Step Size (P & O method):

MATLAB CODE for Fixed Step-Size:

TriggeredSubsystem/MATLAB Function

```
function updated_alpha = Fixed_Controller(difference)
step_size = 5;
persistent alpha;
if isempty(alpha)
    alpha = 0;
end
if difference > 0
    updated_alpha = alpha + step_size;
    alpha = updated_alpha;
elseif difference < 0
        updated_alpha = alpha - step_size;
        alpha = updated_alpha;
else
    updated_alpha = alpha;
end
end
```

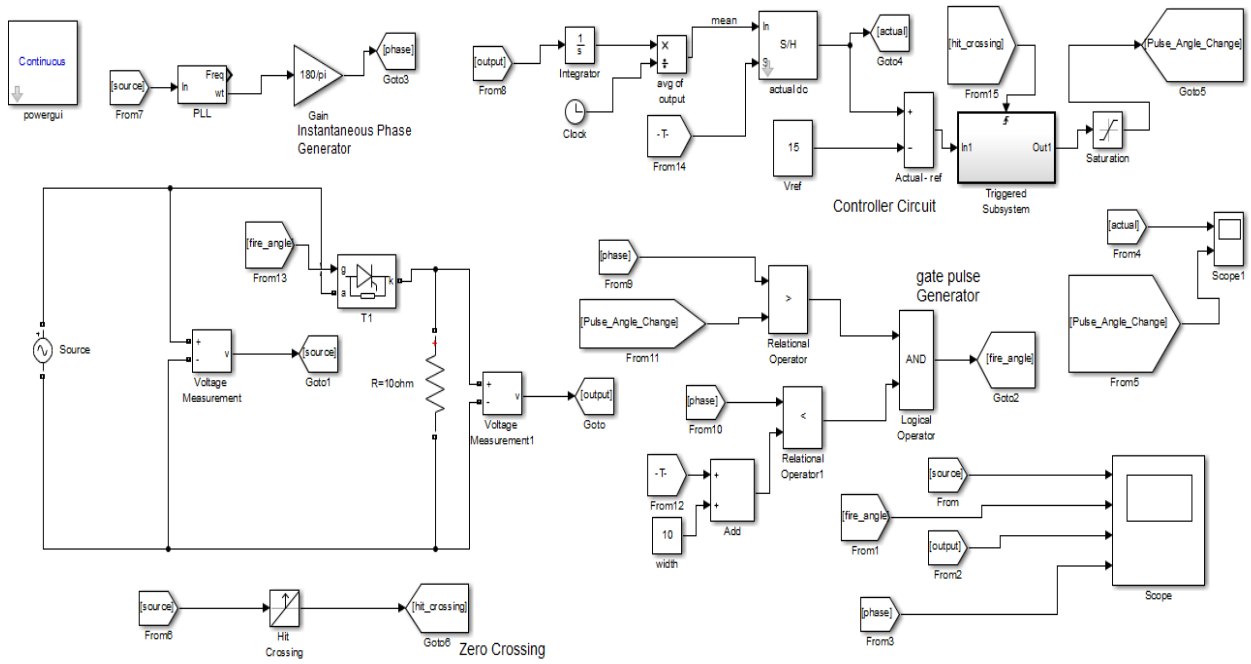

Figure1.3.: Half-Wave Controlled Rectifier with Fixed Step Size (P & O method) where Vref = 15V in Simulink

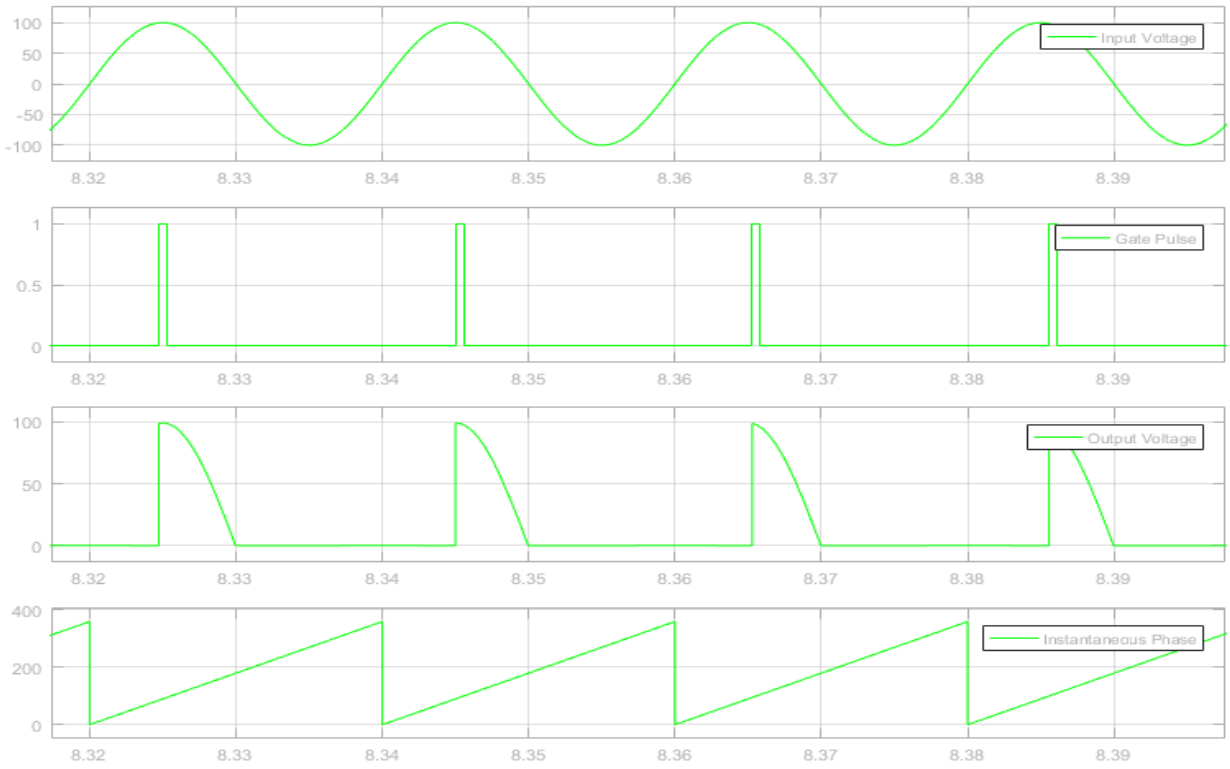

Figure1.4.: Input, Gate Pulse, Output Voltage and Instantaneous Phase of Half -Wave Controlled Rectifier Circuit with Fixed Step Size (P & O method) with Vref = 15V in Simulink

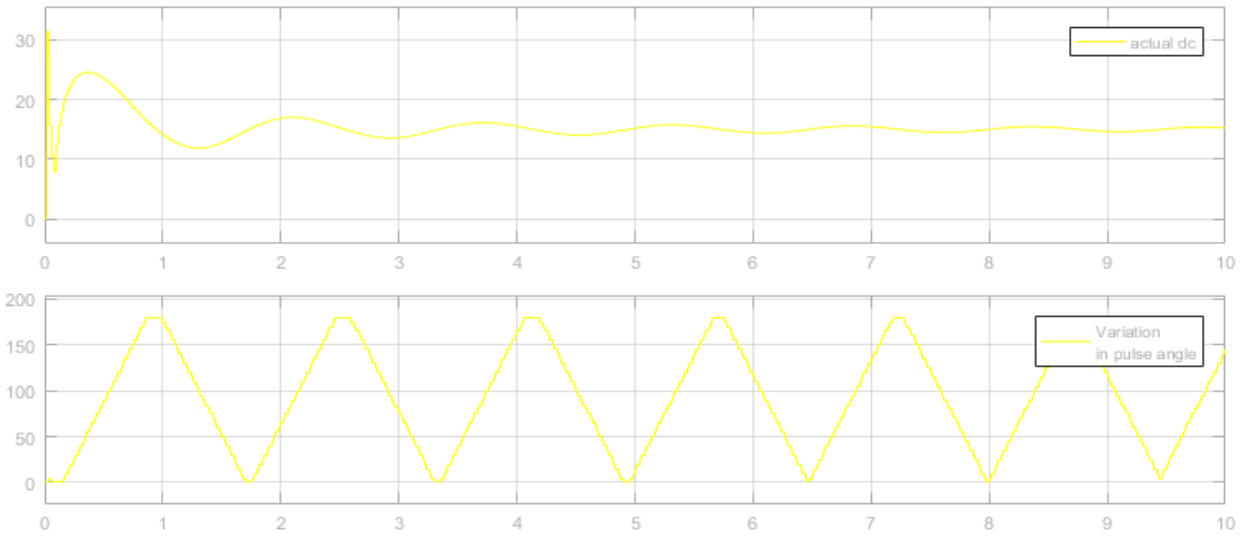

Figure 1.5.: Actual dc and Variation in Pulse angle waveform in of Half -Wave Controlled Rectifier Circuit with Fixed Step Size (P & O method) in Simulink

Half -Wave Controlled Rectifier Circuit with Variable Step Size (P & O method):

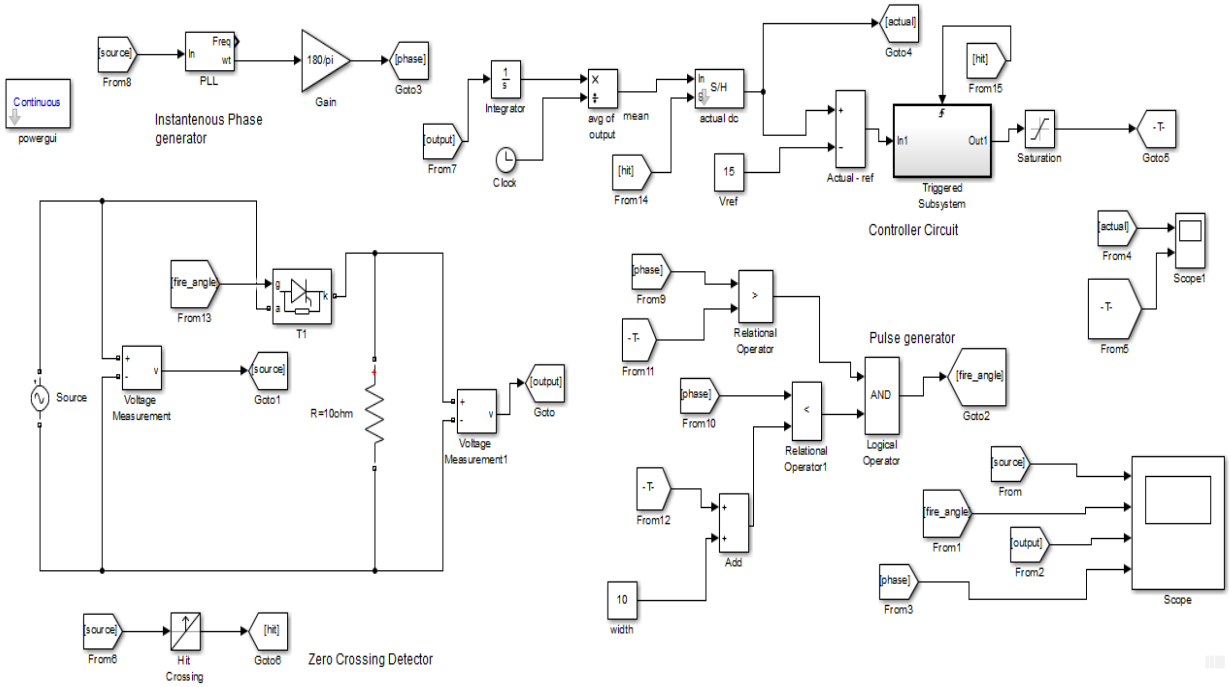

Figure1.6.: Half-Wave Controlled Rectifier with Variable Step Size (P & O method) where Vref = 15V in Simulink

MATLAB CODE for Variable Step Size:

```
function updated_alpha = Variable_Controller(difference)
if difference>10
    step_size = 15;
elseif difference < 10 && difference > 5
    step_size = 10;
else
    step_size = 5;
end
persistent alpha;
if isempty(alpha)
    alpha = 0;
end
if difference > 0
    updated_alpha = alpha + step_size;
    alpha = updated_alpha;
elseif difference < 0
        updated_alpha = alpha - step_size;
        alpha = updated_alpha;
else
    updated_alpha = alpha;
end
end
```

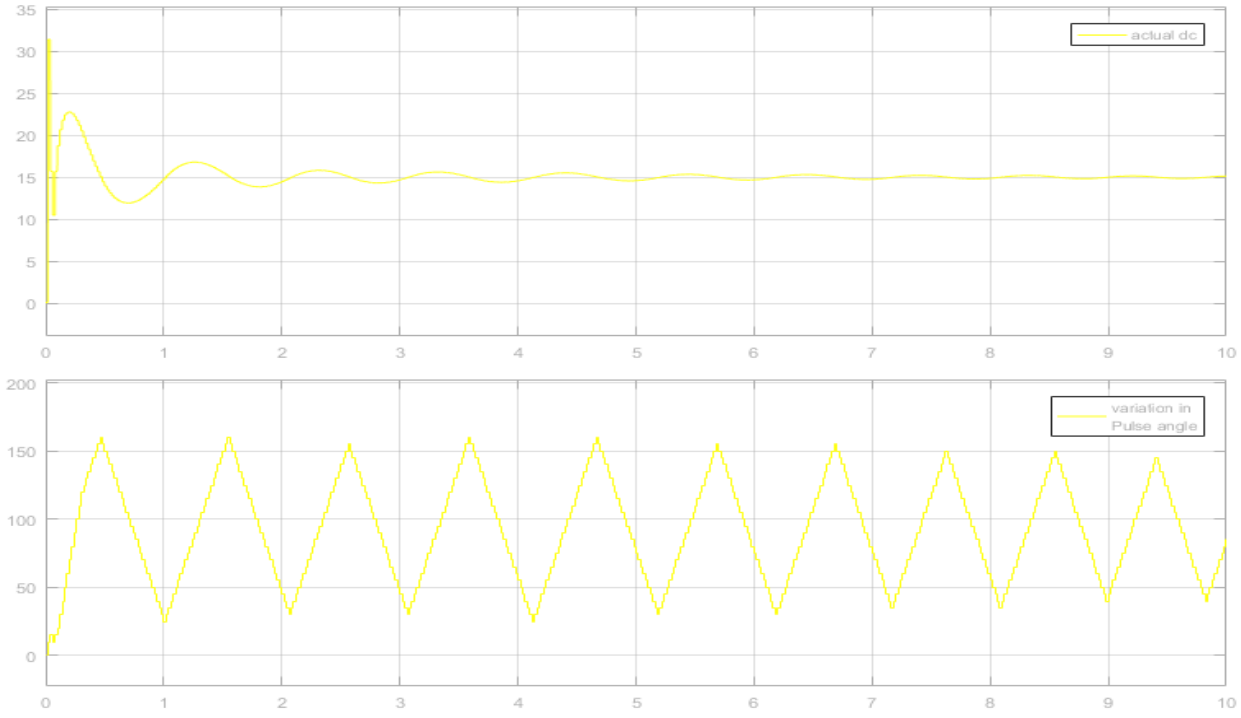

Figure 1.7.: Actual dc and Variation in Pulse angle waveform in of Half -Wave Controlled Rectifier Circuit with Variable Step Size (P & O method) in Simulink

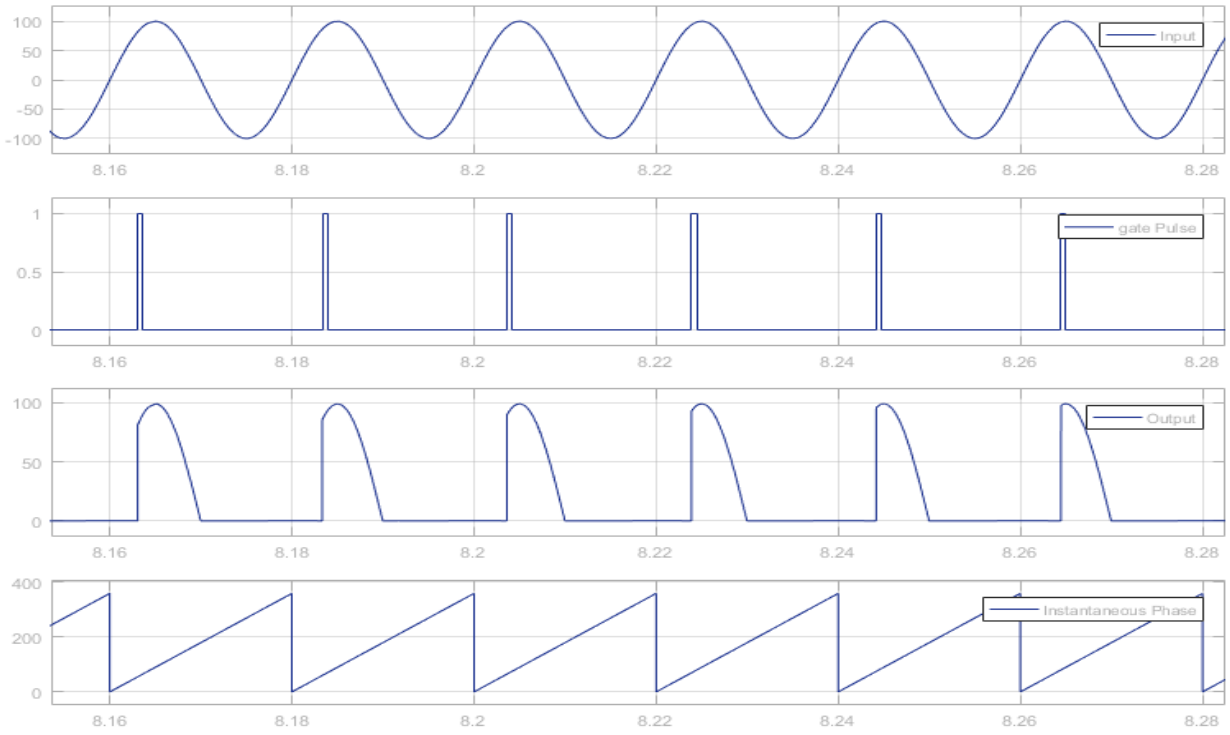

Figure 1.8.: Input, Gate Pulse, Output Voltage and Instantaneous Phase of Half -Wave Controlled Rectifier Circuit with Variable Step Size (P&O method) with Vref = 15V in Simulink

Full-Wave Controlled Rectifier with PI Controller:

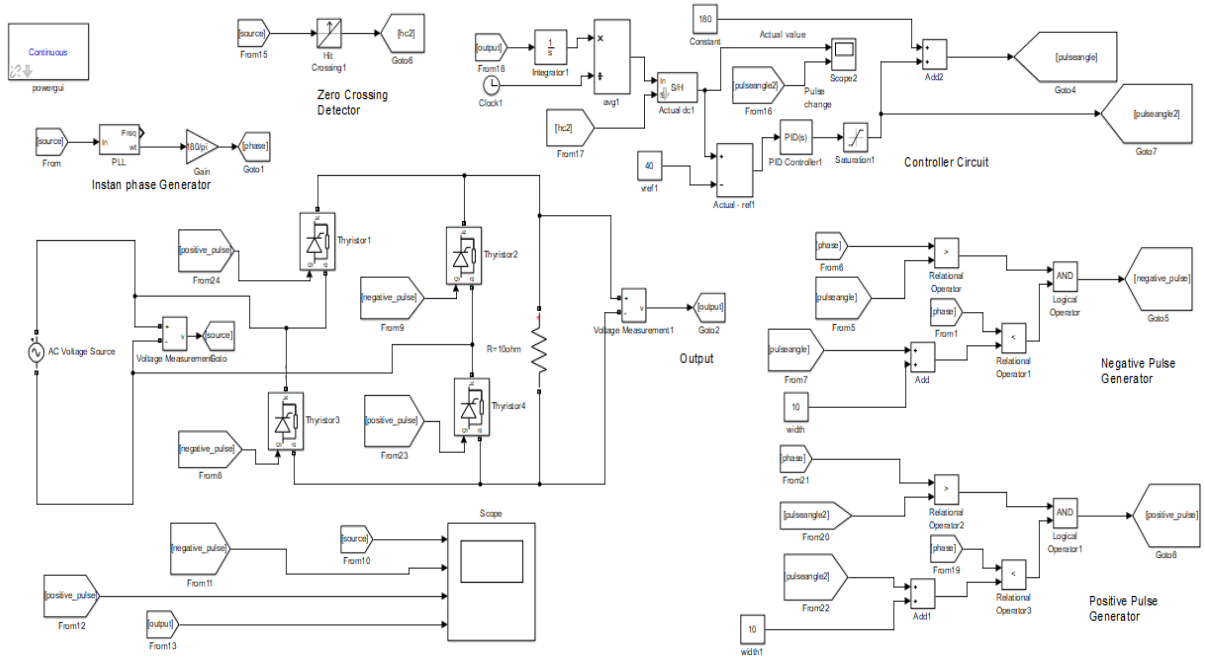

Figure 1.9.: Full Wave Controlled Rectifier Circuit with PI Controller to Achieve Reference Voltage = 40V in Simulink

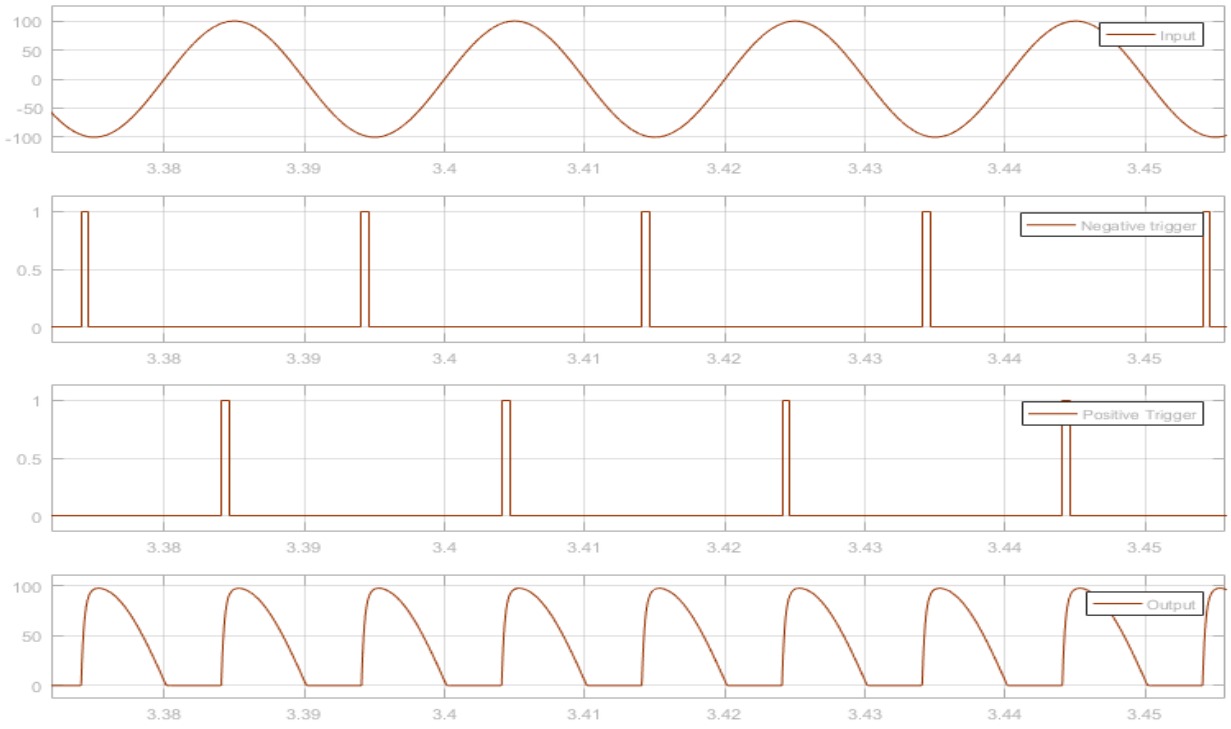

Figure 1.10: Input, Gate Pulse, Output Voltage and Instantaneous Phase of Full -Wave Controlled Rectifier Circuit with PI Controller (Vref = 40V) in Simulink

Full-Wave Controlled Rectifier with fixed Step Size (P&O Method):

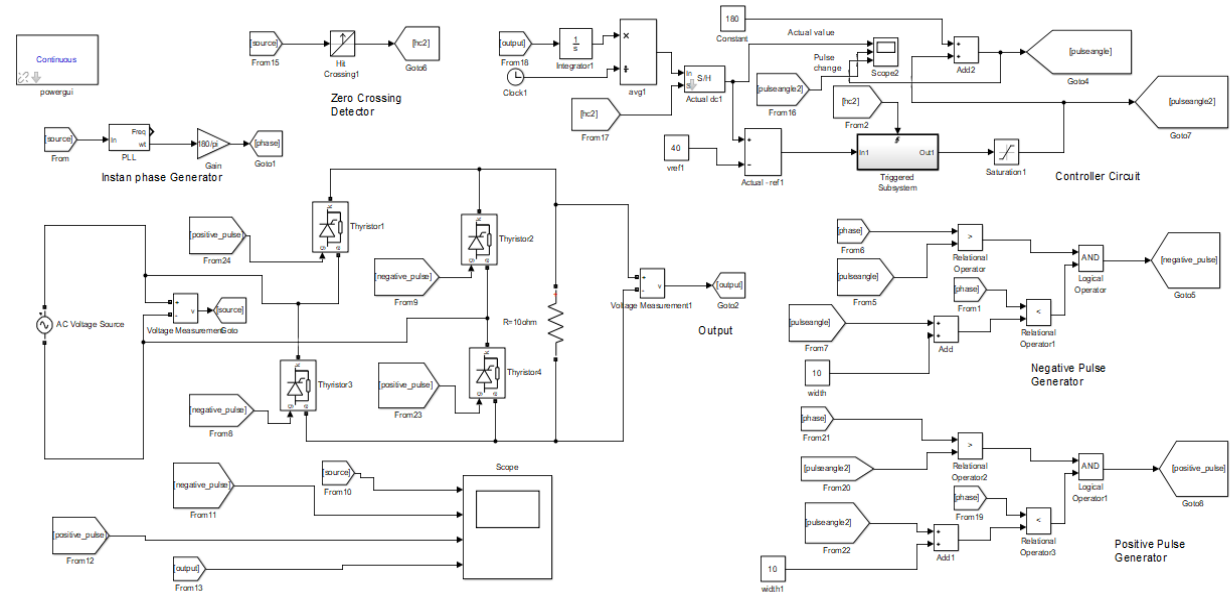

Figure1.11.: Full-Wave Controlled Rectifier with Fixed Step Size (P & O method) where Vref = 40V in Simulink

MATLAB CODE for fixed Step Size:

TriggeredSubsystem/MATLAB Function

```
function updated_alpha = Fixed_Controller(difference)
step_size = 5;
persistent alpha;
if isempty(alpha)
    alpha = 0;
end
if difference > 0
    updated_alpha = alpha + step_size;
    alpha = updated_alpha;
elseif difference < 0
        updated_alpha = alpha - step_size;
        alpha = updated_alpha;
else
    updated_alpha = alpha;
end
end
```

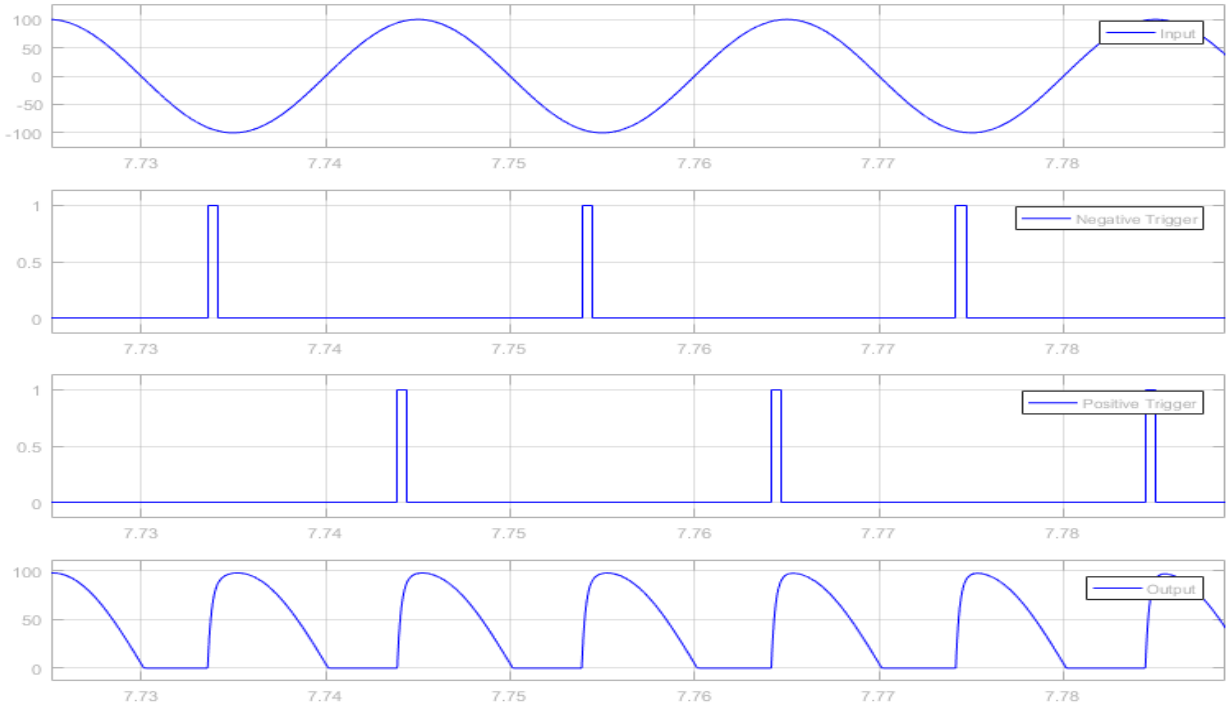

Figure 1.12.: Input, Gate Pulse, Output Voltage and Instantaneous Phase of Full -Wave Controlled Rectifier Circuit with Fixed Step Size (P & O method) with Vref = 40V in Simulink

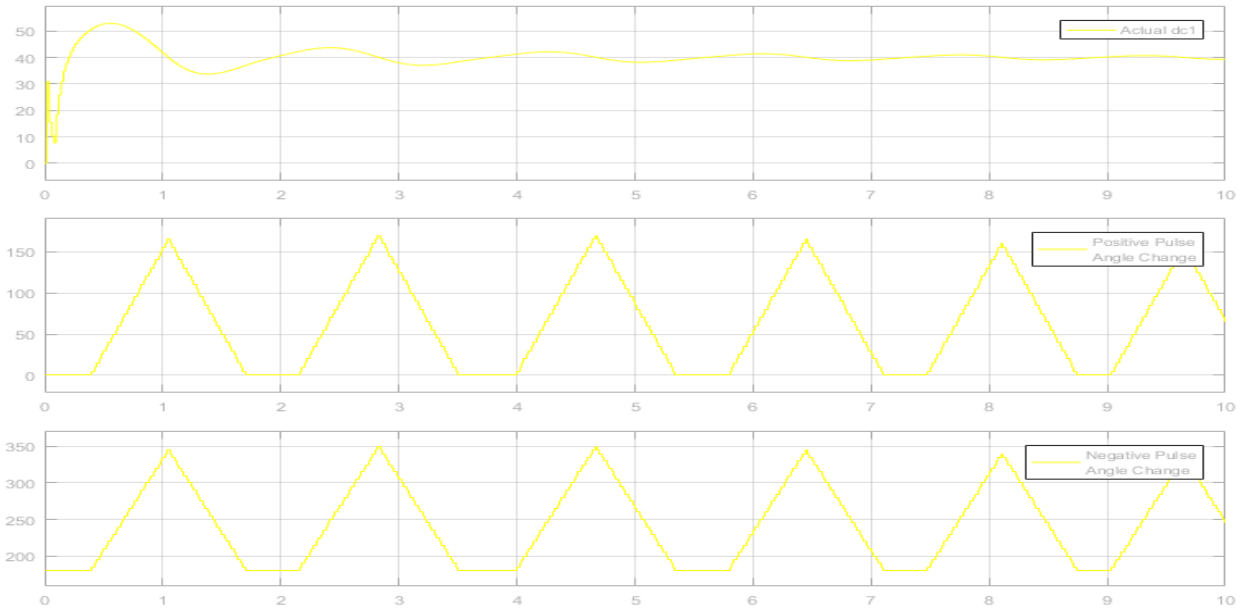

Figure 1.13: Actual dc and Variation in Pulse angle waveform in of Full -Wave Controlled Rectifier Circuit with Fixed Step Size (P & O method) in Simulink

Full-Wave Controlled Rectifier with Variable Step Size (P&O Method):

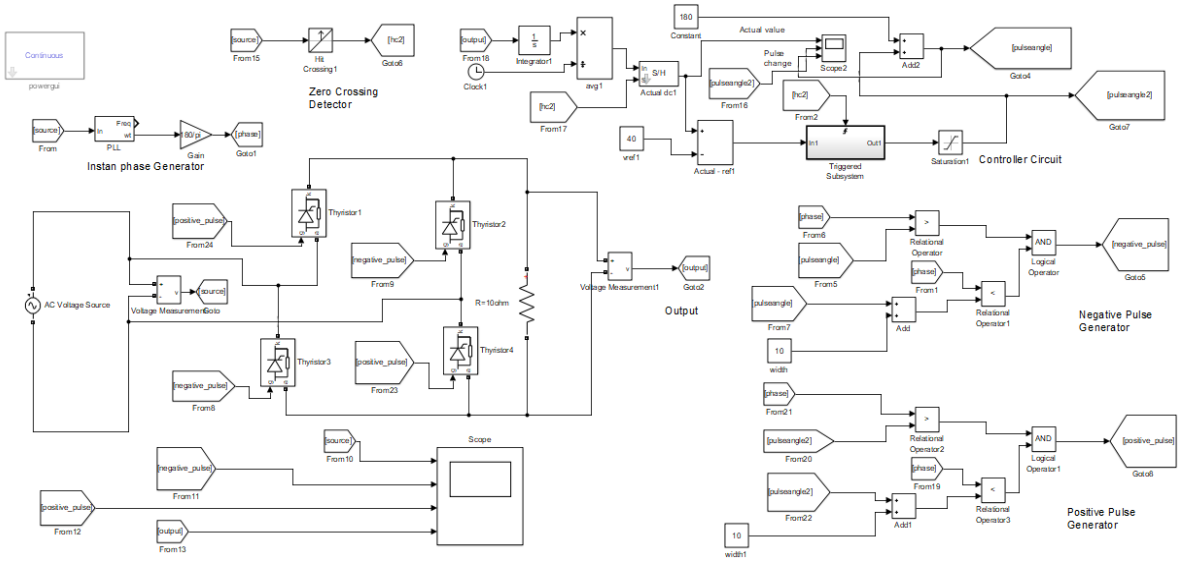

Figure 1.14.: Full-Wave Controlled Rectifier with Variable Step Size (P & O method) where Vref = 40V in Simulink

MATLAB CODE for Variable Step Size:

```
function updated_alpha = Variable_Controller(difference)
if difference>10
    step_size = 15;
elseif difference < 10 && difference > 5
    step_size = 10;
else
    step_size = 5;
end
persistent alpha;
if isempty(alpha)
    alpha = 0;
end
if difference > 0
    updated_alpha = alpha + step_size;
    alpha = updated_alpha;
elseif difference < 0
        updated_alpha = alpha - step_size;
        alpha = updated_alpha;
else
    updated_alpha = alpha;
end
end
```

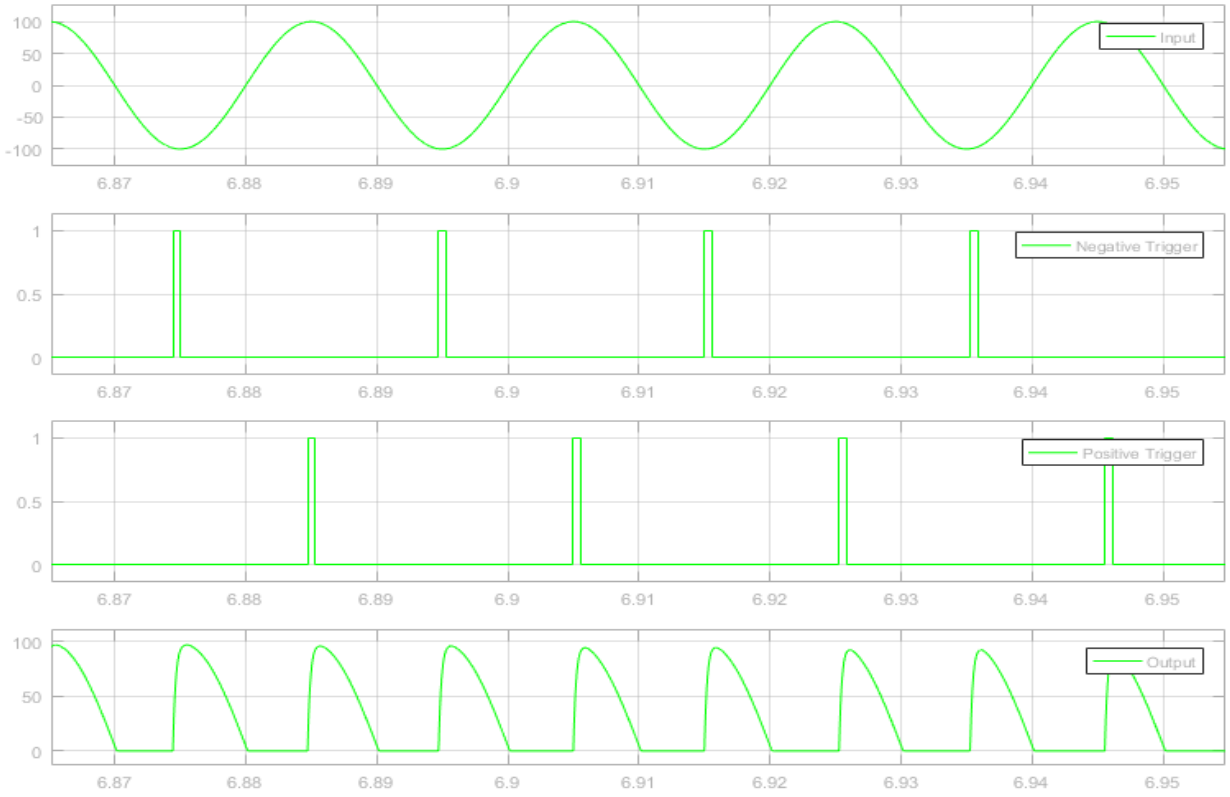

Figure 1.15.: Input, Gate Pulse, Output Voltage and Instantaneous Phase of Full -Wave Controlled Rectifier Circuit with Variable Step Size (P&O method) with Vref = 40V in Simulink

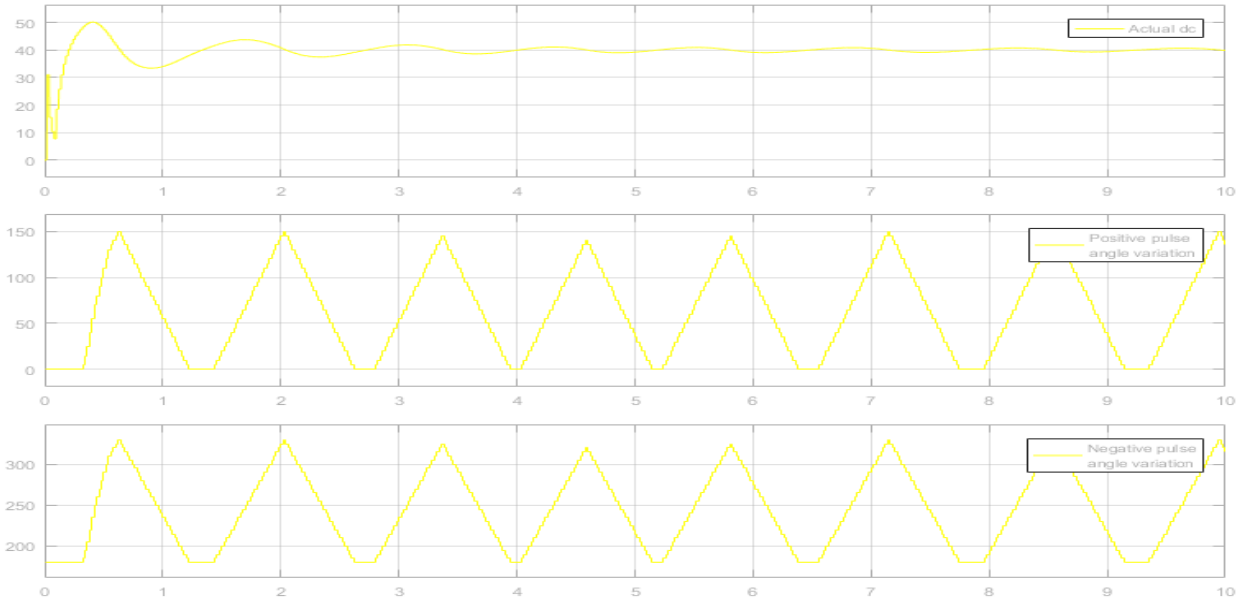

Figure 1.16.: Actual dc and Variation in Pulse angle waveform in of Full -Wave Controlled Rectifier Circuit with Variable Step Size (P & O method) in Simulink

Result & Discussion: In this experiment, half-wave and full-wave controlled rectifier circuit was made using PI controller and (P&O) method with fixed and variable step size. By setting the value of Vref the desired actual dc value was found in the output waveform. These 6 circuits are designed in such a way so that it can give upto maximum convertible dc value in the output where PI controller will automatically fix the firing angle. It can be seen that for different Vref value different firing angle was set accordingly. Also, it can be seen that for fixed step size the steady state error was more than found in the variable step size which can be compared by observing figure 1.16,1.13, 1.7, 1.5. For variable step size the steady state error was minimum. In full-wave rectifier circuit the negative pulse was created by phase shifting the positive pulse angle by 180 degree. The experiment was done carefully and the MATLAB codes logics were produced according to the desired circuit. By observing the result or input-output waveform with phase and pulse angle it can be said that the desired value was yielded in this simulation. So, the simulation was done successfully and expected result was found.